

Development of MULTIPORT DRYER TECHNOLOGY for the Forest Products Industry

Argonne National Laboratory (ANL)

U.S. Choi, PI

Kadant-Johnson, Industrial Partner

International Paper, Industrial Partner

Presented by

David M. France

University of Illinois at Chicago (UIC) & ANL



Objective

- **Technical objective**
 - **Improve heat transfer rates in steam drum dryers of paper producing machines to increase efficiency**



Approach

- Reduce heat transfer resistance of condensing steam inside drum dryers
- Utilize Multiport Dryer technology
 - Based on ANL single-port experiments
- Design insert to extend Multiport Dryer technology to retrofit full size dryers
 - Full scale experimental dryer
 - Production steam dryers – field retrofit



Project Goals

- Verify Multiport Dryer concept in laboratory testing
- Demonstrate Multiport Dryer technology to increase drying rates in full scale *existing* dryers at competitive costs
 - Design and fabricate prototype Multiport Dryers
 - Conduct Multiport dryer performance tests in full-scale steam dryers for *retrofit* applications
 - Transfer Multiport Dryer technology to industry
 - ✓ Paper presented Oct 2003 at TAPPI Technical Conf. recipient of Best DOE paper/project award

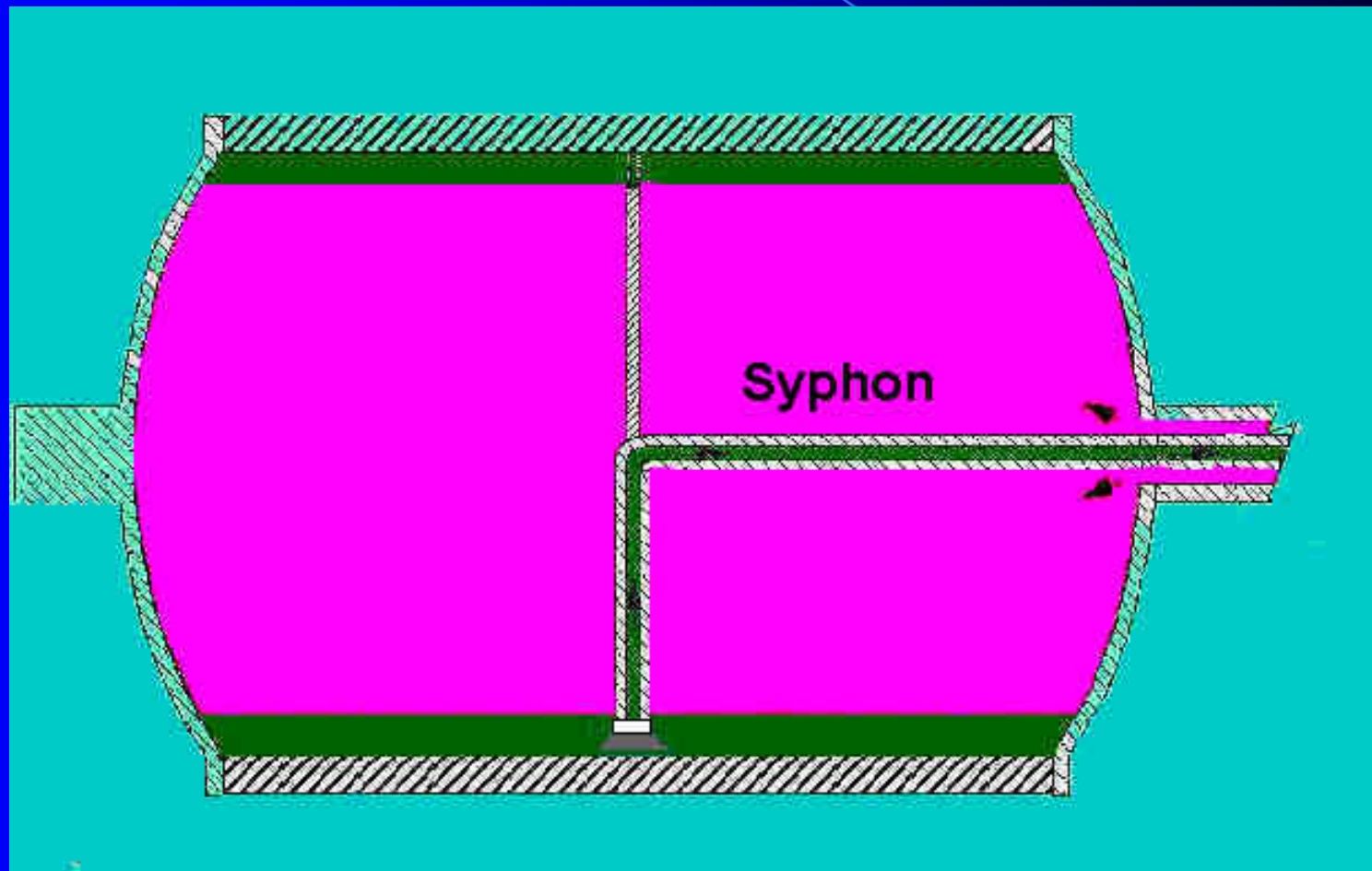


Multiport Dryer Concept

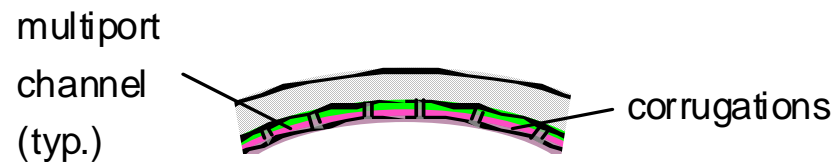
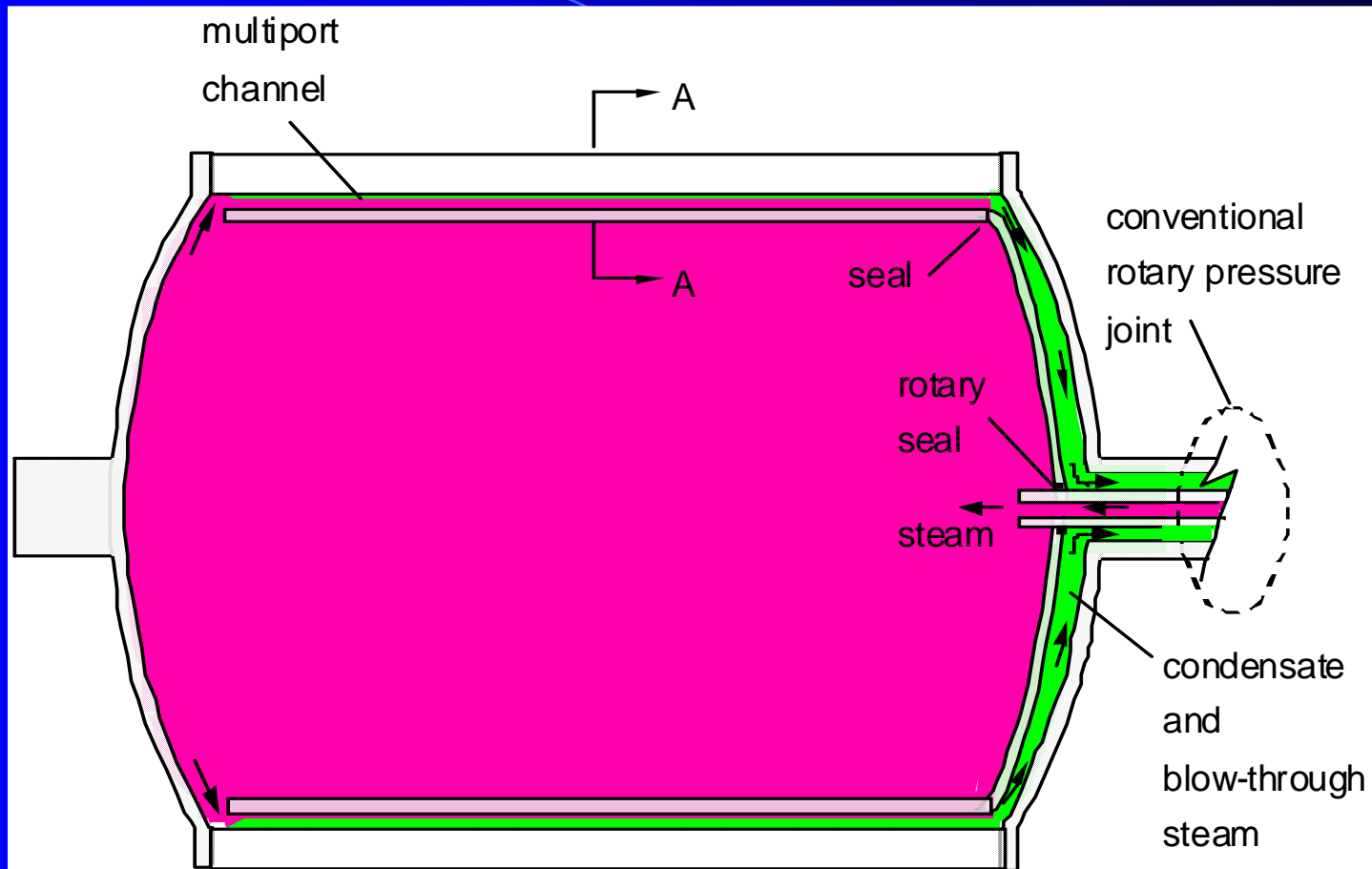
- **Conventional cylinder dryer**
 - Steam fills the entire cylinder and is substantially insulated from the surface by the slow moving condensate film.
- **Multiport cylinder dryer**
 - Steam flows through small ports (small longitudinally-oriented flow passages) close to the cylinder surface where it is needed
 - ✓ Flow velocity is high
 - ✓ Condensate film is very thin



Conventional Dryer Concept



Multiport Dryer Concept



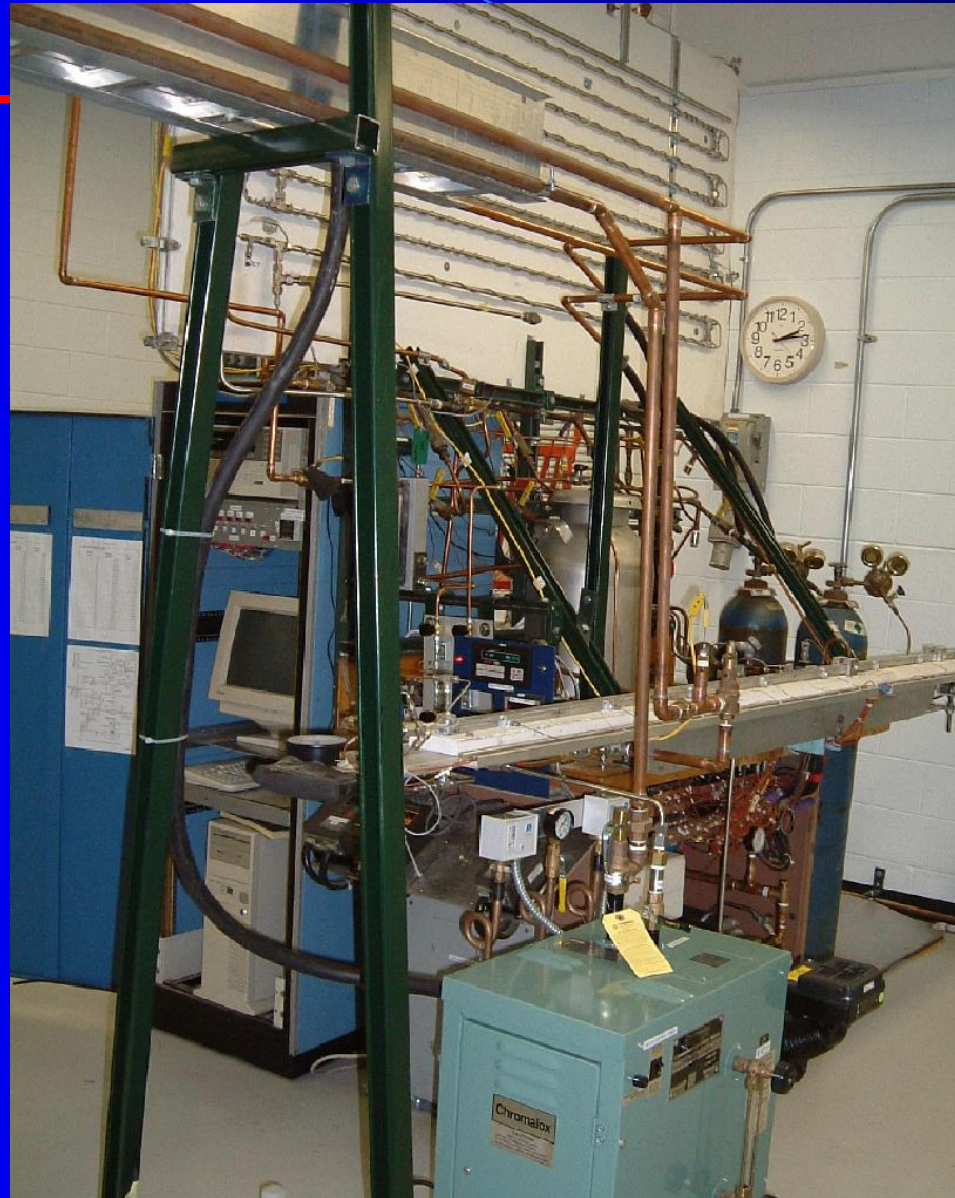
Section A-A

Industrial Advantages

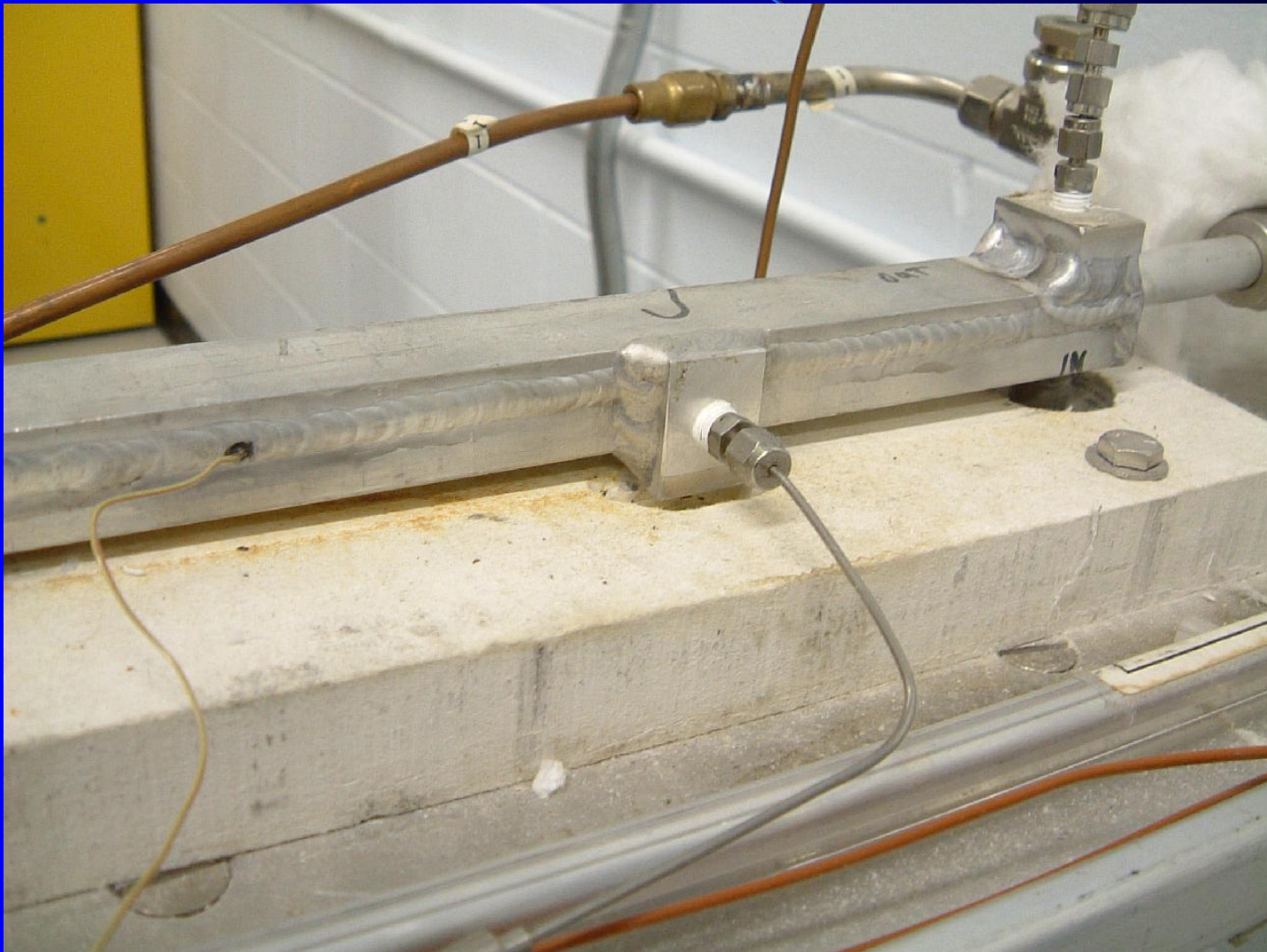
- **Multiport Dryer options**
 - Increase paper making productivity by 20% to 50%
 - Reduce size of paper machines (no. of steam dryers)
 - Produce thicker paper types
 - Reduce energy consumption at current productivity
 - ✓ Potential = 17 trillion Btu/year (170 million therms/year)
- **Impact 12,000 US dryers**



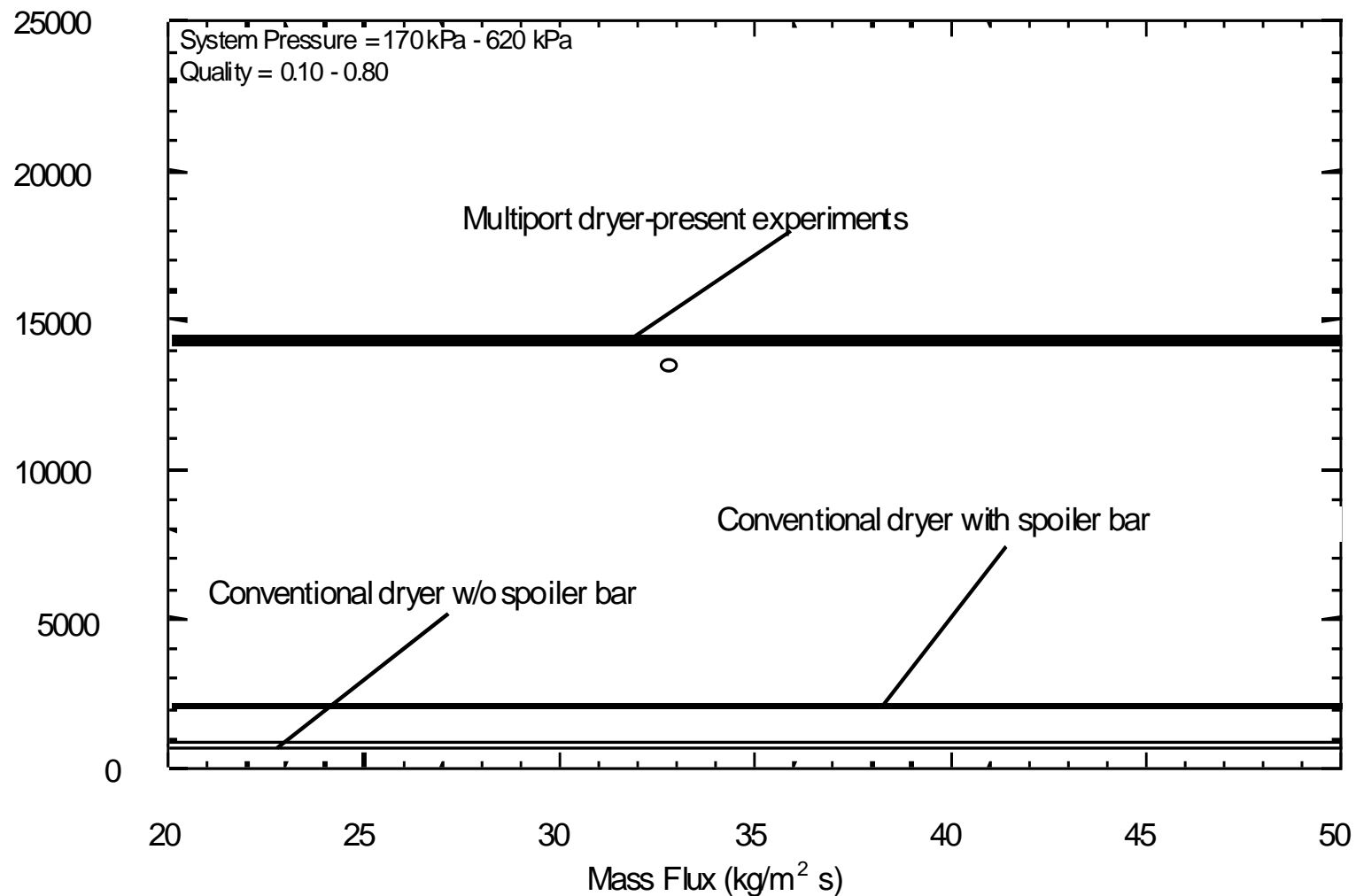
ANL Multiport Dryer Experimental Facility



ANL Multiport Dryer Test Channel



ANL Test Results – 7x to 20x Increased Heat Transfer Coefficient (W/m² K) (20% to 50% increased heat transfer rate)



The KEY to Dramatic Increase in Heat Transfer in Multiport Dryers Compared to Conventional Dryers

- In striking contrast to conventional dryers, the "rim of condensate" is minimized in Multiport Dryers.
- Higher velocity steam in Multiport Dryers increases convection heat transfer which is markedly more effective than conduction through the thicker stagnant liquid film in conventional dryers.



Multiport Dryer Insert Design Criteria

- **Full scale**
 - Designed for Kadant-Johnson full-size, experimental, steam drum dryer
- **Differential design pressure = 210 kPa**
- **Field installable**
 - Access through manhole



Kadant-Johnson Full Scale Test Dryer



Kadant-Johnson Shortened Steam Dryer



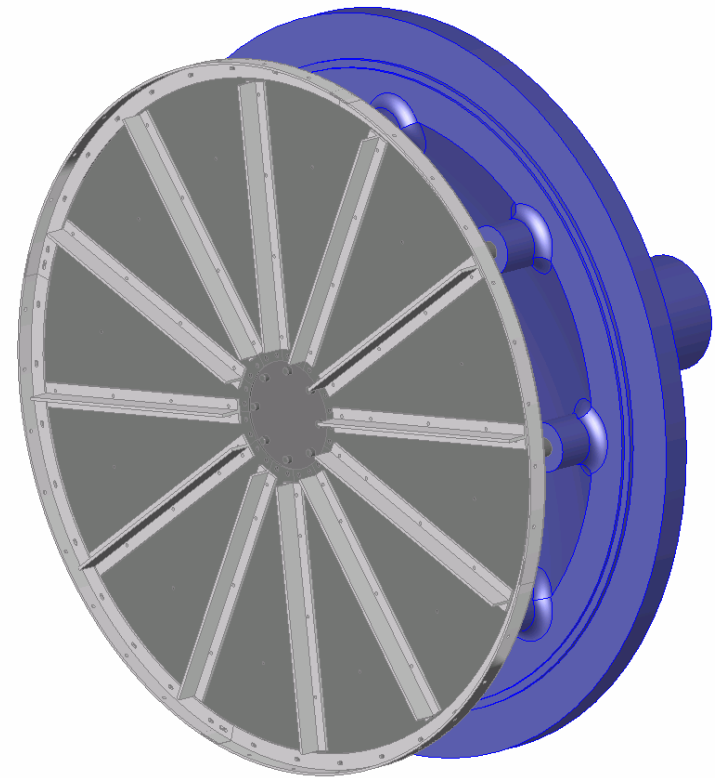
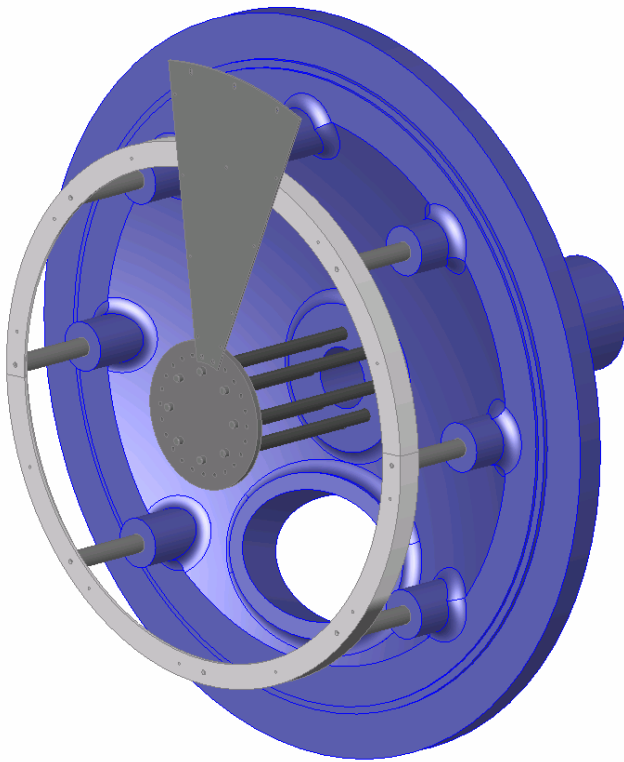
- All Multiport insert components enter through manhole
- Multiport insert assembled inside dryer

Inside of Shortened Dryer

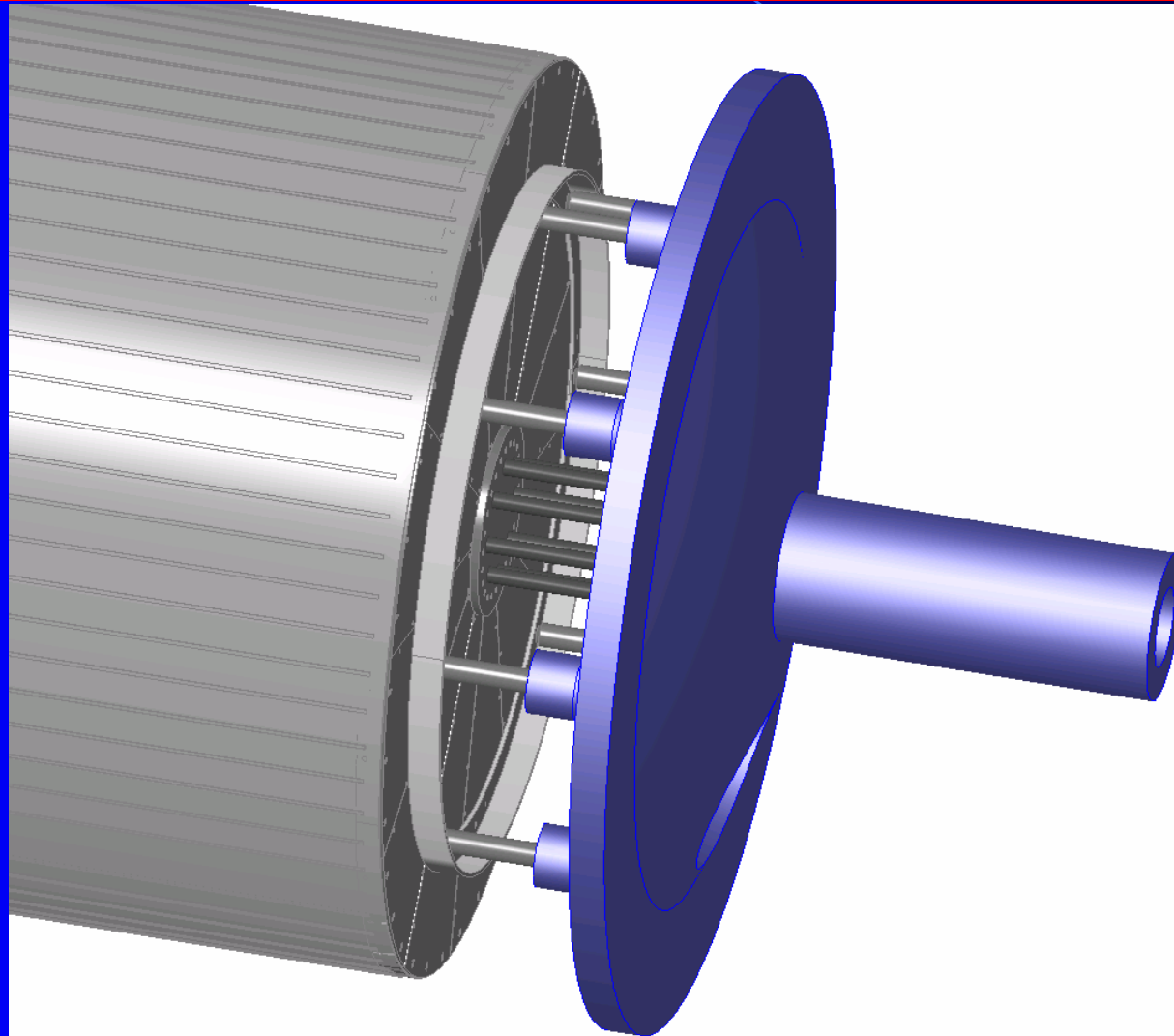


- Attachment bosses for Multiport insert
- Conventional Spring Ring to be used with Multiport insert

Schematic of Multiport Insert Partially Assembled



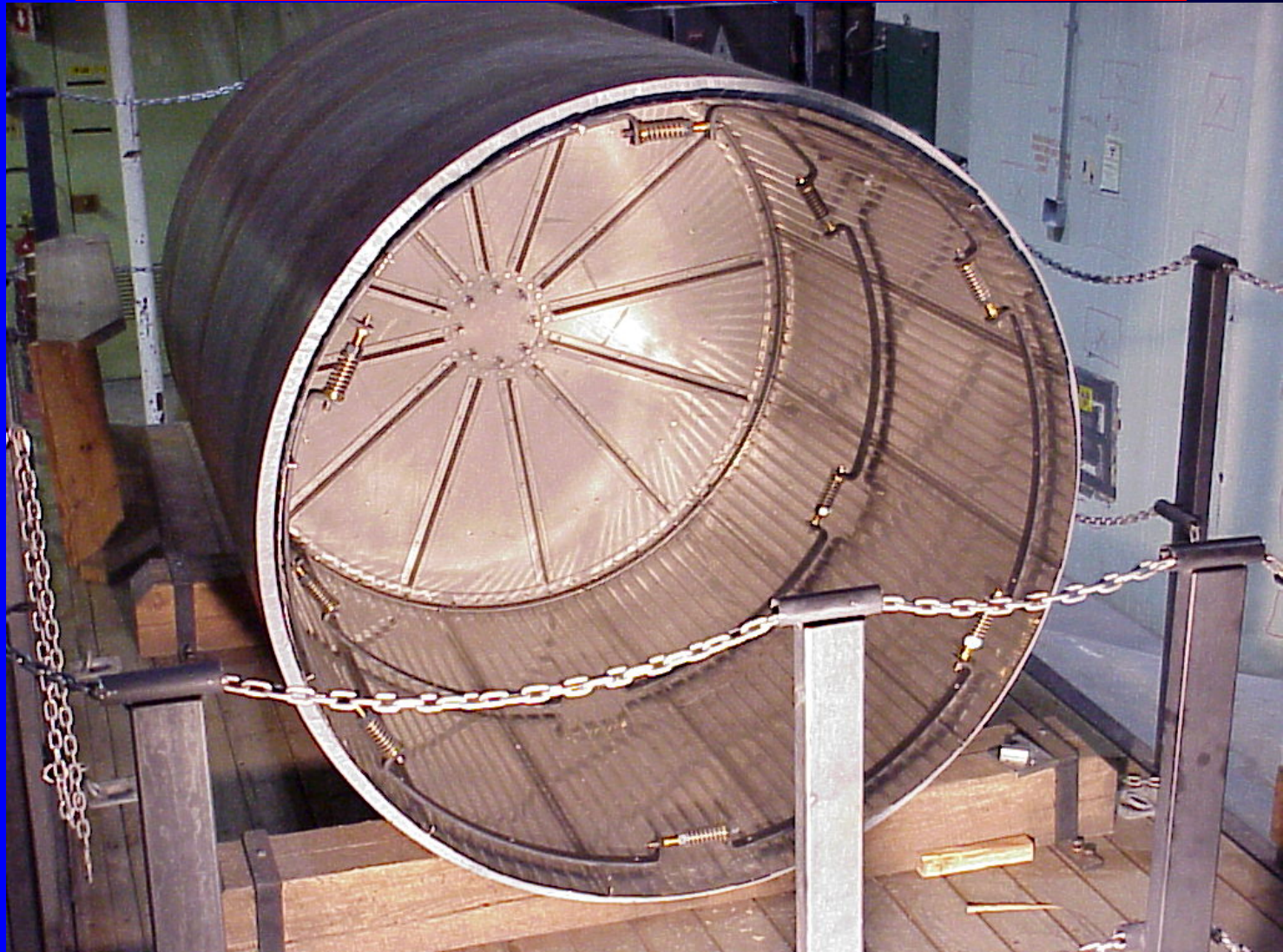
Schematic of Multiport Insert Fully Assembled



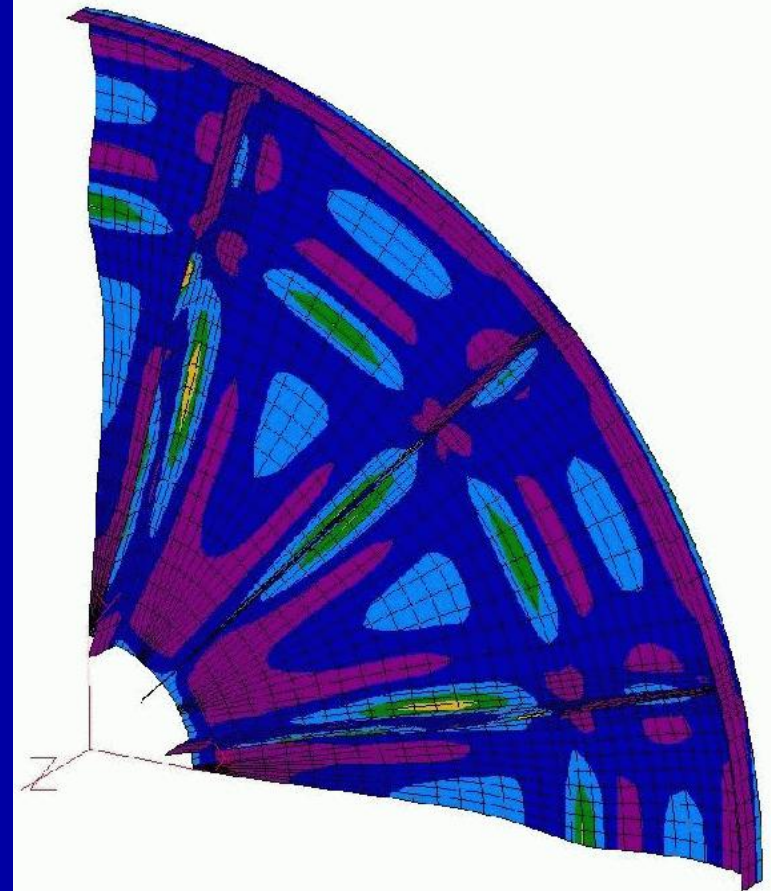
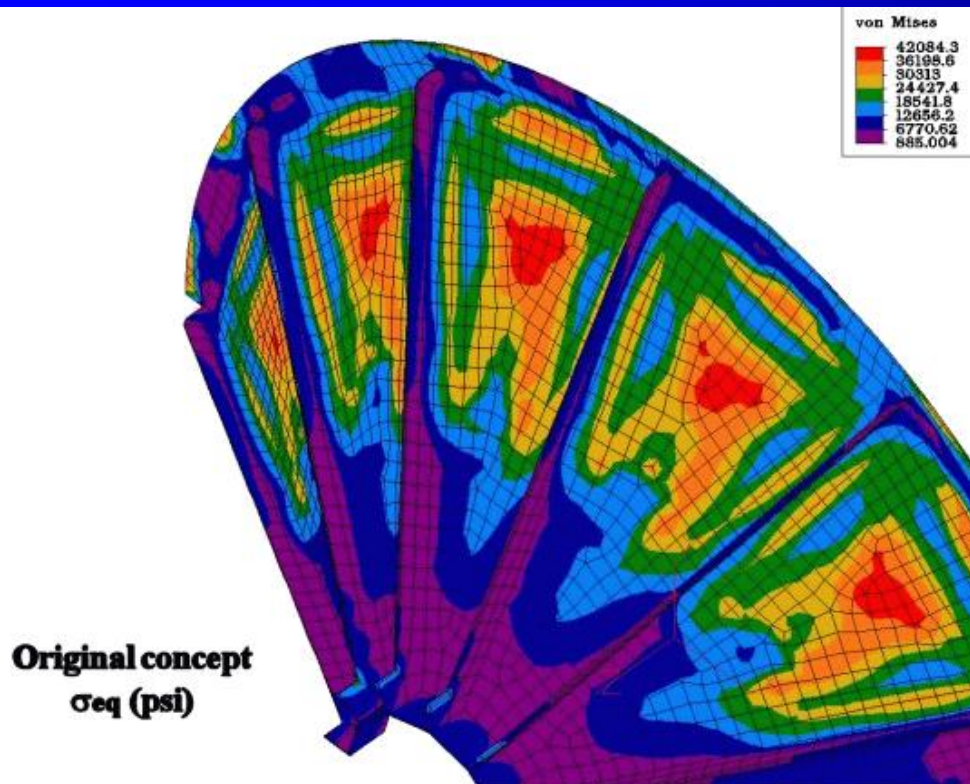
Multiport Insert Fabrication



Multiport Insert Installed in Shortened Dryer



Stress Analysis of Insert Head



Smoke Test of Multiport Insert



Multiport Dryer Design Modifications

- Shortened dryer installation
 - Several areas identified to ease field installation, e.g.
 - ✓ Fastener specifications
 - ✓ Final panel adjustment
 - ✓ Temporary panel support
- Smoke test
 - Potentially small steam by-pass path

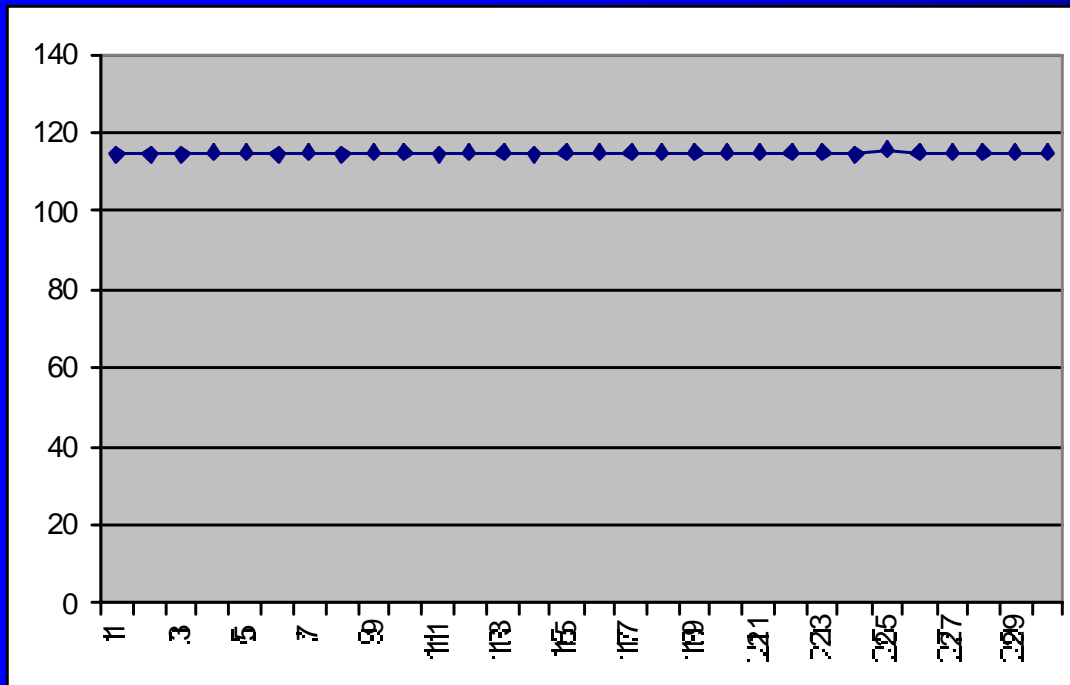


Simultaneous Multiport & Spoiler Bar Testing

- Divide 20 ft long dryer in 2 equal sections
 - ½ length fitted with Multiport Dryer insert
 - ½ length fitted with Spoiler bars
- Measure heat transfer in both sections in every test
- Direct comparison of two technologies in full scale test
- Scheduled completion: Oct 1, 2006



Baseline Tests in Kadant-Johnson Dryer



- **Dryer surface temperature (C)**
 - Uniform along dryer length
 - Tested with spoiler bars
 - To be compared to same test with Multiport Dryer Insert

Future Work

- **Kadant-Johnson full scale experimental dryer**
 - Compete design and fabrication of Multiport insert
 - Utilize components from shortened dryer assembly
 - Perform comparative testing
- **Production Steam Dryers**
 - Enhance Multiport Dryer insert design for field retrofit to a large range of production steam dryers
 - Retrofit and test Multiport Dryer inserts in production paper machine dryers
- **Complete data analysis of extended laboratory testing**



Conclusions

- **Present Multiport Dryer Technology**
 - Concept verified in laboratory tests
 - Installation in shortened full scale dryer
 - ✓ Design modifications to ease field installation
 - ✓ Design modifications to minimize steam by-pass
 - Insert design modifications & fabrication being completed for retrofit into full scale experimental steam dryer
- **Next – full scale testing**
 - Experimental steam dryer
 - Production steam dryer

